In his very extensive work KLEBS has always maintained that the action of red light was due to the fact that it has high photosynthetic action. SCHANZ's work suggests that the effect may be due in part to the fact that it eliminates detrimental ultra violet rays.

This very important work of SCHANZ merits checking up and extending. The work with ultra violet light has been largely with artificial spectra much richer in ultra violet than the solar spectrum, and too little exact study has been made of the formative effects of the ultra violet of the latter spectrum.

A very noteworthy piece of work by GARNER and ALLARD,[8] reviewed in detail elsewhere in this journal, should be mentioned in this connection. It is possible that the remarkable effects they obtain from length of day is due to the fact that it modifies the nitrogen *carbohydrate* ratio of which FISCHER, KRAUS and KRAYBILL,[9] and others have made so much as a determiner of the course of development, whether vegetation shall dominate or there shall be a balance of vegetation and reproduction.

In the small dosages of light used in phototropic and photo-growth response, the most effective region of the spectrum on the basis of equal energy value lies at λ 505 $\mu\mu$ for the sporangiophore of *Phycomyces;* at λ 467 $\mu\mu$ for the coleoptile of *Avena;* and at λ 494 $\mu\mu$ for *Volvox,* as previously given. Perhaps with the high dosage of natural illumination the effective region shifts still more to the right as is indicated by SCHANZ's work.

A comprehensive study of the formative effect of light on plants is much needed to see to what degree its formative action is due to synthetic activity, to the so-called photo-growth responses, to various effects of ultra violet rays, and to other effects not included in these.—WM. CROCKER.

Effect of light exposure on plant growth.—GARNER and ALLARD[10] have grown plants under different conditions of light exposure, and have made a special study of the tendency to become reproductive or to remain vegetative under varying daily lengths and intensities of exposure. Several varieties of tobacco and soy bean were mainly used in the experimental work, although numerous other species of annuals and biennials were used to check the results attained.

Plants were grown in pots, buckets, or boxes, and at the desired time each day were moved into dark chambers which were placed in the field. For the last season's work, large dark houses were constructed, in such a way that plants could be moved in or out at any time. Time of exposure to light

[8] GARNER, W. W., and ALLARD, H.A., Effect of relative length of day and night and other factors of the environment on growth and reproduction in plants. Jour. Agric. Res. **18**:553–606. 1920.

[9] BOT. GAZ. **67**:445–446. 1919.

[10] GARNER, W.W., and ALLARD, H. A., Effect of relative length of day and night and other factors of the environment on growth and reproduction in plants. Jour. Agric. Res. **18**:553–606. 1920.

varied in the different tests from 5 hours daily to full daylight, 7 and 12 hours being the exposures chiefly used. Checks received full daylight under similar conditions of temperature. Shorter light exposures were all made during the middle of the day, and during the time of highest light intensity, except one series of soy beans which were kept in darkness from 10:00 A.M. to 2:00 P.M. daily.

In general, the amount of vegetative growth was proportional to the length of daily exposure to light. The short exposures resulted in short, slender plants of greatly reduced size. Rate of growth was much slower, and the total size attained was reduced. The inception of the flowering or reproductive phase was greatly influenced by length of exposure to light. Many of the species worked with were thrown into flowering and fruiting by the shorter exposures, while with certain other species and varieties, reducing the period of illumination had little effect upon the inception of fruiting.

The authors conclude that for each plant there is a "critical" length of daylight exposure essential to the development of the fruiting phase. The length of this critical exposure varies with each species and variety, but, in many individuals at least, is very much shorter than normal summer daylight. By exposing the plants to this critical length of illumination, the reproductive or flowering phase can be induced at almost any time. By varying this time of exposure, typical biennials, as *Aster linariifolius*, could be made to complete their life cycles within a few months, while annuals, as soy beans, *Solidago*, etc., could be induced to respond as biennials.

Experiments with shading indicated that time of exposure, and not light intensity, is the primary factor involved in determining the critical day. Light intensity reduced to 43 per cent by shading had no effect upon the time of inception of fruiting, although it did give typical shading results on form and amount of growth. Of significance, however, is the result obtained from exposing soy bean morning and afternoon, but keeping it in darkness during midday. Time of fruiting was not materially altered by this treatment, although it was much advanced in the same variety by reducing the exposure to light through leaving in darkness morning and evening. Reducing the water supply reduced vegetative growth and fruit yield, but did not alter time of fruiting in the least. Winter light, supplemented by artificial illumination at night, giving a total daily exposure of 18 hours, acted exactly as long summer daylight in its tendency to retard or prevent fruiting. The authors believe length of day, through its influence on fruiting and seed formation, to be a fundamental factor in plant distribution.

No attempt has been made by the authors to explain how length of day might thus determine the form of plant development. It is unfortunate that a more careful review of the literature was not given, as the authors have made no attempt to link their work to other very critical studies along this line. KLEBS found that by varying the salt nutrients, he could induce vegetative or reproductive growth at will, over a very wide range of plants.

He found high salt supply gives vegetative growth, while low salt supply induces fruiting. FISCHER found that increasing photosynthesis and the supply of carbohydrate material, through increased CO_2 pressure, the nitrogen supply remaining constant, induces the reproductive phase. Finally, in a series of very critical experiments and analyses, KRAUS and KRAYBILL found that a relative abundance of carbohydrate over nitrogenous material in the plant induces fruitfulness, while a relatively greater nitrogen supply induces vegetative growth. Excessive carbohydrate over nitrogen inhibited both vegetative and reproductive growth. All of this work shows a very close relation between the conditions of nutrition in the plant and the type of growth expression. GARNER and ALLARD have undoubtedly made a contribution of great value to the subject of vegetation and reproduction in plants. The reviewer feels, however, that their conclusions are much broader than a careful review of the whole subject warrants. It would be difficult, for example, to explain the phenomenon of alternate fruiting in many of our orchards on the basis of length of day influence. A critical study of the nitrogen and carbohydrate metabolism under these reduced exposures to illumination would be of great value in arriving at an understanding of the many factors in plant growth and reproduction.—J. R. MAGNESS.

Ecological research.—In a report of research in progress under the direction of the Carnegie Institution, Director MACDOUGAL[11] reports progress upon a number of interesting problems. SHREVE has continued investigations upon the vegetation of the arid Avra Valley, and reports progress in a soil temperature survey of the United States and Canada. CANNON presents some conclusions derived from a field study of the vegetation of central, northern, and southwestern South Australia, as well as some further results in the investigations of the reactions of roots to varying amounts of carbon dioxide in the soil. He has also some data as to the size and form of leaves of desert plants. COOPER reports the beginnings of a study of the strand vegetation of the Pacific Coast at Coronado and Monterey, California. These regions possess interesting dune areas, upon which various plant associations, varying from pioneer herbaceous to chaparral and forest communities, have become established. These communities are being mapped, permanent quadrats and transects established, and the underground portions of many species excavated and studied. Measurements of evaporation, soil moisture, and soil temperature have been made, and material collected for anatomical studies. MACDOUGAL and SPOEHR are conducting investigations to discover the origin of xerophytism in plants, and Mrs. SHREVE has records extending over several years of seasonal changes in the water relations of such desert plants as *Encelia farinosa*, *Streptanthus arizonicus*, and *Amaranthus Palmeri*.—GEO. D. FULLER.

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[11] MACDOUGAL, D. T., Ecology. Carnegie Inst. Wash. Year Book for 1919. **18**:87–102. 1920.